Kakra Hughes, MD, PhD, SECTION EDITOR

An international, expert-based, Delphi consensus document on controversial issues in the management of abdominal aortic aneurysms

Kosmas I. Paraskevas, MD,[a] Marc L. Schermerhorn, MD, FACS,[b] Stephan Haulon, MD, PhD,[c] Adam W. Beck, MD, FACS,[d] Hence J. M. Verhagen, MD, PhD,[e] Jason T. Lee, MD, FACS,[f] Eric L. G. Verhoeven, MD, PhD,[g] Jan D. Blankensteijn, MD, PhD,[h] Tilo Kölbel, MD, PhD,[i] Sean P. Lyden, MD, FACS,[j] Daniel G. Clair, MD, FACS,[k] Gianluca Faggioli, MD, PhD,[l,m] Theodosios Bisdas, MD, PhD,[m] Mario D'Oria, MD, PhD,[o] Kevin Mani, MD, PhD,[p] Karl Sörelius, MD, PhD,[q,r] Enrico Gallitto, MD, PhD,[l,m] Jose Fernandes e Fernandes, MD, PhD, FACS, FRCS, FESC, FEBVS,[s] Athanasios Katsargyris, MD, PhD,[g,t] Sandro Lepidi, MD, PhD,[n] Andrea Vacirca, MD, PhD,[l,m] Piotr Myrcha, MD, PhD,[u] Mark J. W. Koelemay, MD, PhD,[v] Armando Mansilha, MD, PhD,[w] Clark J. Zeebregts, MD, PhD,[x] Rodolfo Pini, MD, PhD,[l,m] Nuno V. Dias, MD, PhD,[y] Angelos Karelis, MD, PhD,[z] Michel J. Bosiers, MD, PhD,[z] David H. Stone, MD, FACS,[aa] Maarit Venermo, MD, PhD,[ab] Mark A. Farber, MD, FACS,[ac] Matthew Blecha, MD, FACS,[ad] Germano Melissano, MD, PhD,[ae] Vincent Riambau, MD, PhD,[af] Matthew J. Eagleton, MD, FACS,[ag] Mauro Gargiulo, MD, PhD,[l,m] Salvatore T. Scali, MD, FACS,[ah] Giovanni B. Torsello, MD, PhD,[ai] Mark K. Eskandari, MD, FACS,[aj] Bruce A. Perler, MD, FACS,[ak] Peter Gloviczki, MD, FACS,[al] Mahmoud Malas, MD, FACS,[am] *and* Ronald L. Dalman, MD, FACS,[l] *Athens, Greece; Boston, MA; Paris Saclay, France; Birmingham; AL; Rotterdam, Amsterdam, and Groningen, the Netherlands; Stanford and San Diego, CA; Nuremberg, Hamburg, Germany, and Münster; Cleveland, OH; Nashville, TN; Bologna, Trieste and Milan, Italy; Uppsala and Malmö, Sweden; Copenhagen, Denmark; Lisbon and Porto, Portugal; Warsaw, Poland; Bern, Switzerland; Lebanon, NH; Helsinki, Finland; Chapel Hill, NC; Chicago, IL; Barcelona, Spain; Gainesville, FL; Baltimore, MD; and Rochester, MN*

From the Department of Vascular Surgery, Red Cross Hospital, Athens[a]; the Division of Vascular and Endovascular Surgery, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston[b]; the Aortic Center, Marie Lannelongue Hospital, Groupe Hospitalier Paris Saint Joseph, Paris Saclay University, Paris Saclay[c]; the Division of Vascular Surgery and Endovascular Therapy, University of Alabama at Birmingham, Birmingham[d]; the Department of Vascular Surgery, Erasmus University Medical Center, Rotterdam[e]; the Division of Vascular Surgery, Stanford University School of Medicine, Stanford[f]; the Department of Vascular and Endovascular Surgery, General Hospital and Paracelsus Medical University, Nuremberg[g]; the Department of Vascular Surgery, Amsterdam University Medical Center, Amsterdam[h]; the German Aortic Center, Department of Vascular Medicine, University Medical Center Eppendorf, Hamburg[i]; the Department of Vascular Surgery, Cleveland Clinic, Cleveland[j]; the Department of Vascular Surgery, Vanderbilt University Medical Center, Section of Surgical Sciences, Nashville[k]; the Department of Vascular Surgery, University of Bologna - DIMEC[l]; the Vascular Surgery Unit, IRCCS Sant'Orsola, Azienda Ospedaliero-Universitaria, Bologna[m]; the 3rd Clinic of Vascular Surgery, Athens Medical Center, Athens, Greece[n]; the Department of Vascular and Endovascular Surgery, Department of Clinical Surgical and Health Sciences, University of Trieste, Trieste[o]; the Section of Vascular Surgery, Department of Surgical Sciences, Uppsala University, Uppsala[p]; the Department of Vascular Surgery, Rigshospitalet, University of Copenhagen, Copenhagen[q]; the Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen[r]; the Department of Vascular Surgery, University of Lisbon, Lisbon Academic Medical Center, Lisbon[s]; the Second Department of Vascular Surgery, National and Kapodistrian University of Athens, Laiko General Hospital, Athens[t]; the Department of General and Vascular Surgery, Faculty of Medicine, Medical University of Warsaw, Warsaw[u]; the Department of Surgery, Amsterdam UMC, University of Amsterdam, Amsterdam Cardiovascular Sciences, Amsterdam[v]; the Department of Angiology and Vascular Surgery, Sao Joao University Hospital, University of Porto, Porto[w]; the Division of Vascular Surgery, Department of Surgery, University Medical Center Groningen, University of Groningen, Groningen[x]; the Vascular Center Malmö, Skåne University Hospital and Department of Clinical Sciences Malmö, Lund University, Malmö[y]; the Department of Vascular Surgery, University Hospital Bern, University of Bern, Bern[z]; the Section of Vascular Surgery, Dartmouth-Hitchcock Medical Center, Lebanon[aa]; the Department of Vascular Surgery, Helsinki University Hospital, University of Helsinki, Helsinki[ab]; the Vascular Surgery Division, Department of Surgery, School of Medicine, University of North Carolina, Chapel Hill[ac]; the Division of Vascular Surgery, Stritch School of Medicine, Loyola University of Chicago, Chicago[ad]; the Department of Vascular Surgery, Vita-Salute San Raffaele University School of Medicine, IRCCS San Raffaele Hospital, Milan[ae]; the Department of Vascular Surgery, Cardiovascular Institute, Hospital Clinic Barcelona, University of Barcelona[af]; the Division of Vascular and Endovascular Surgery, Massachusetts General Hospital, Boston[ag]; the Division of Vascular Surgery and Endovascular Therapy, University of Florida, Gainesville[ah]; the Institute for Vascular Research, St. Franziskus Hospital, Münster[ai]; the Division of Vascular Surgery, Department of Surgery, Northwestern University Feinberg School of Medicine, Chicago[aj]; the Department of Surgery, The Johns Hopkins Hospital, Baltimore[ak]; the Division of Vascular and Endovascular Surgery, Gonda Vascular Center, Mayo Clinic, Rochester[al]; and the Division of Vascular and Endovascular Surgery, Department of Surgery, University of California San Diego Health System, San Diego[am]

Additional material for this article may be found online at www.jvascsurg.org.

Correspondence: Kosmas I. Paraskevas, MD, Department of Vascular Surgery, Red Cross Hospital, 24, Al. Papagou Str, Athens 14122, Greece (e-mail: paraskevask@hotmail.com).

The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

https://doi.org/10.1016/j.jvs.2024.08.012

ABSTRACT

Objective: As a result of conflicting, inadequate or controversial data in the literature, several issues concerning the management of patients with abdominal aortic aneurysms (AAAs) remain unanswered. The aim of this international, expert-based Delphi consensus document was to provide some guidance for clinicians on these controversial topics.

Methods: A three-round Delphi consensus document was produced with 44 experts on 6 prespecified topics regarding the management of AAAs. All answers were provided anonymously. The response rate for each round was 100%.

Results: Most participants (42 of 44 [95.4%]) agreed that a minimum case volume per year is essential (or probably essential) for a center to offer open or endovascular AAA repair (EVAR). Furthermore, 33 of 44 (75.0%) believed that AAA screening programs are (probably) still clinically effective and cost effective. Additionally, most panelists (36 of 44 [81.9%]) voted that surveillance after EVAR should be (or should probably be) lifelong. Finally, 35 of 44 participants (79.7%) thought that women smokers should (or should probably/possibly) be considered for screening at 65 years of age, similar to men. No consensus was achieved regarding lowering the threshold for AAA repair and the need for deep venous thrombosis prophylaxis in patients undergoing EVAR.

Conclusions: This expert-based Delphi consensus document provides guidance for clinicians regarding specific unresolved issues. Consensus could not be achieved on some topics, highlighting the need for further research in those areas. (J Vasc Surg 2025;81:483-92.)

Keywords: Abdominal aortic aneurysm; EVAR; Perioperative mortality; Delphi; AAA; Open surgical repair

Despite the release of Clinical Practice Guidelines by both the Society for Vascular Surgery (SVS)[1] and the European Society for Vascular Surgery (ESVS),[2] the data for some topics in the management of patients with infrarenal abdominal aortic aneurysms (AAAs) is inadequate, conflicting, and/or controversial. In the recent 2024 ESVS[2] guidelines, 474 new references published between 2019 and 2023 were used compared with the 2019 ESVS AAA guidelines,[3] including 16 primary or secondary analyses from randomized controlled trials (RCTs), 106 systematic reviews and/or meta-analyses, and 84 studies based on vascular registries or quality initiative programs. Despite this new evidence, only 10 of 160 recommendations (6%) were based on Level A evidence, of which 5 were Class I and 2 were Class III.[2] As many as 112 (70%) recommendations were limited to Level C evidence or committee consensus, illustrating the overall insufficient level of evidence regarding many issues concerning the management of patients with AAAs.

Owing to the lack of robust evidence, several questions remain unanswered. The aim of this international, expert-based Delphi consensus document was to summarize the available evidence on some of these controversial issues and to provide some guidance to clinicians dealing with these issues in everyday clinical practice.

METHODS

An international, expert-based Delphi consensus document was prepared in accordance with the Conducting and Reporting Delphi Studies Checklist.[4] A total of 44 experts (15 from the United States and 29 from Europe) were invited to participate. All participants had ≥10 years of relevant clinical experience in the management of AAA patients and proof of relevant academic expertise, as documented by relevant publications on PubMed/MedLine.

After a search on PubMed/Medline and after receiving feedback from the Delphi participants, a total of six controversial topics were identified (Fig). A total of three rounds were undertaken. During round 1, the participants provided an initial response to each of the identified topics. All responses were answered in prespecified seven-answer format (yes — probably yes — possibly yes — uncertain/unknown/unproven/no opinion — possibly no — probably no — no). During round 2, all participants were asked the same questions after being provided with relevant articles from the available international literature (Appendix, online only). After the first version of the manuscript was circulated among the group, all participants were asked to finalize their responses (round 3). All participants provided their responses to all three rounds of the Delphi consensus document. Consensus was reached when ≥70% of the participants agreed on a response showing preference for a specific approach (eg, yes/probably yes or no/probably no). The ≥70% threshold has been used in similar Delphi consensus documents in the literature.[5-9] The participants had 2 weeks to provide their responses during each round.

The response uncertain/unknown/unproven/no opinion included one or more of the following:

a. The evidence supporting or refuting a particular question is inadequate, controversial, or conflicting, and/or
b. The participant does not think that either a positive or a negative response is possible to answer a specific question, and/or
c. The participant does not feel that one of the available answers can fully cover the topic.

All responses were collected anonymously. To avoid any potential bias, no participant was identified or was made aware of the identity of the comments by another member of the panel. No discussion of the results was

• Q1: Should the size threshold for elective AAA repair be lowered to 5.0 cm for male and to 4.8 cm for female patients in the endovascular era?

• Q2: Are AAA screening programs still clinically effective and cost-effective today?

• Q3: Is prophylaxis for deep venous thrombosis needed for patients undergoing EVAR?

• Q4: Should there be a minimum case volume for a center to offer open AAA repair/EVAR?

• Q5: Should surveillance after EVAR be lifelong?

• Q6: Should women smokers be screened for AAAs at 65 years of age similar to men?

Fig. The topics of the questionnaire for the Delphi consensus document on abdominal aortic aneurysms (*AAAs*). *EVAR*, endovascular abdominal aortic aneurysm repair.

permitted between the Delphi consensus participants. Only the Delphi consensus coordinator (K.I.P.) was aware of each participant's identity and responses.

RESULTS

A consensus by ≥70% of the participants was achieved in some topics, but not in others. Overall, 40 of 44 participants (91%) modified their response in at least one of the topics from round 1 to round 2 or from round 2 to round 3 (eg, from probably yes to possibly yes'). Most participants (42 of 44 [95.4%]) believed that a minimum case volume per year is essential for a center to offer open AAA repair/EVAR. Of these, 5 of the 42 participants (11.9%) made a clear distinction between open AAA repair and EVAR; although a minimum annual volume was thought to be essential for open AAA repair procedures to maintain the required skills and the low perioperative mortality and morbidity rates, this was not judged to be a prerequisite for standard infrarenal EVAR procedures.

Furthermore, 33 of 44 participants (75.0%) believed that AAA screening programs are still/are probably still clinically effective and cost-effective. Of these, 4 of the 33 (12.1%) supported that AAA screening programs may be clinically effective, but were unsure if they are still cost-effective. Additionally, most panelists (36 of 44 [81.9%]) voted that surveillance after EVAR should be lifelong, although 3 of 36 (8.3%) supported that surveillance may no longer be meaningful after some time (eg, after 8-10 years), if the patient gets too old, and/or is no longer fit for an additional procedure (if he/she requires one), or there is complete regression of the AAA sac. Finally, 35 of 44 participants (79.7%) thought that women smokers should or should probably/possibly be considered for screening at 65 years of age, similar to men.

No consensus was achieved on whether the threshold for intervention should be lowered and on the need for thromboprophylaxis in patients undergoing EVAR.

DISCUSSION

The responses of the 44 Delphi consensus participants for each topic are presented, analyzed and discussed.

Should the size threshold for elective AAA repair be lowered to 5.0 cm for male and to 4.8 cm for female patients in the endovascular era?. According to the 2018 SVS guidelines,[1] elective repair is recommended for males with an asymptomatic fusiform AAA ≥55 mm (Level of recommendation: 1 [strong]; Quality of Evidence: A [high]) and females with an asymptomatic AAA ≥50 mm (Level of recommendation: 2 [weak]; Quality of Evidence: B [moderate]). The more recent 2024 ESVS Guidelines recommended that men with an AAA ≥55 mm should (Class: IIa; Level of Evidence: B) and women with an AAA ≥50 mm may be considered for elective repair (Class: IIb; Level of Evidence: C).[2] The European guidelines recommended against elective repair of AAAs <55 mm in men (Class III, Level of Evidence: A) and 50 mm in women (Class III, Level of Evidence: C).[2] Contrary to these recommendations, up to nearly 40% of AAAs in the United States are repaired below the recommended thresholds.[10-12] Of 44,820 elective AAA repairs in the Vascular Quality Iniatitive, 17,057 (38%) were below the currently recommended size thresholds (40% EVAR and 26% open AAA repair).[12] Patients who were operated below size recommendations had lower in-hospital death than those who were repaired above the recommended threshold (for EVAR: 0.3% vs 0.8%, respectively [$P < .0001$]; for open AAA repair: 2.4% vs 4.6%, respectively [$P < .0001$]).[12] There were several reasons for offering elective repair below the recommended thresholds, eg, concomitant iliac aneurysm (23%), saccular AAA (10%), rapidly expanding AAA (10%), patient anxiety (7%), distal embolism (3%), not documented (41%), and other (6%).[12]

In a recent analysis of the Vascular Quality Initiative database of all ruptured AAA cases between 2003 and 2020, 12.2% of ruptures occurred in small (<5.5 cm for males and <5.0 cm for females) AAAs (mean AAA diameter, 42.3 mm).[13] Patients with small ruptured AAAs were more likely to be younger, African American, have a lower body mass index, and have hypertension.[13]

Similar conclusions were reached in an earlier independent study evaluating characteristics and outcomes of small AAA ruptures in the American College of Surgeons National Surgical Quality Improvement Program database from 2011 to 2018.[14] Of 1612 repairs performed for ruptured AAA, 167 (10.4%) were for small AAAs. The mean small, ruptured AAA diameter was 4.1 cm in women and 4.5 cm in men.[14] Patients presenting with a ruptured small AAA once again had a significantly

lower body mass index and were more likely to be African American and to have hypertension.[14]

In contrast, a recent study used a Markov chain analysis to estimate life expectancy and AAA rupture rates for patients with AAAs.[15] It was demonstrated that the annual risk of all-cause mortality under surveillance for a 60-year-old man presenting with a 5.5-cm AAA is 2.3%, 2.9%, 3.3%, and 3.4% using repair thresholds of 5.5 cm, 6.0 cm, 6.5 cm, and 7.0 cm, respectively.[15] The corresponding risk for a 60-year-old woman presenting with a 5.0-cm AAA was 1.7%, 2.3%, 2.7%, and 2.8% for the same repair thresholds, respectively. It was supported that for a 60-year-old woman in average health, an AAA repair size of 6.1 cm was the optimal threshold to minimize AAA-related mortality, whereas it was 6.9 cm for a 60-year-old man in average health.[15] For men and women in poor health, the optimal AAA repair size threshold was >8.0 and >6.5 cm, respectively.[15] It was claimed that the optimal threshold for AAA repair varies with patient sex, age, and comorbidities, and there seems to be a range of AAA sizes for which repair is reasonable. However, all AAA sizes are greater than the current guideline recommendations.[15] It was therefore concluded that contemporary AAA size thresholds for repair should be reconsidered.[15]

A key point to consider is the difference in orthogonal and axial measurements when calculating the maximum aortic diameter. Axial measurements overestimate the maximum diameter by ≤12.3 mm.[16] This point is crucial because an AAA may have an axial maximum diameter of >5.5 cm, indicating the need for intervention, whereas the orthogonal diameter is below the threshold.[16]

As a result of the conflicting results from the literature, there was no consensus reached among the Delphi participants about whether the size threshold for elective repair should be lowered to <5.0 cm for males and <4.8 cm in women. Most participants (28 of 44 [63.6%]) thought that the size threshold for elective repair should not or should probably/possibly not be lower than the currently recommended values, while approximately a third of the panelists (15 of 44 [34.1%]) voted that the size threshold should or should probably/possibly be lowered in the endovascular era (Table I). The Women's Aneurysm Research: Repair Immediately Or Routine Surveillance (WARRIORS) trial is an upcoming international RCT evaluating whether or not women with small asymptomatic AAAs would benefit from being offered EVAR at smaller diameters than the currently recommended in clinical guidelines.[17] The results of this RCT will hopefully provide a more definitive answer on the topic.

Are AAA screening programs still clinically effective and cost effective today?. According to the 2018 SVS practice guidelines for AAA patients,[1] a one-time ultrasound screening should be offered in men and women aged 65 to 75 years with a history of smoking (Grade 1A). A weaker recommendation was provided for men and women >75 years in good health and history of tobacco use who were not previously screened (Grade 2C) and first-degree relatives aged ≥65 years of patients presenting with an AAA who are in good health (Grade 2C). The 2024 ESVS[2] Guidelines changed their recommendation from 2019, where they recommended population screening for all men at age 65 years (Class I; Level of Evidence A),[3] and recommended ultrasound screening for the early detection of AAA in high-risk populations to decrease death from AAA rupture (Class I; Level of Evidence: A). The definition of high-risk populations varies based on local conditions, such as disease prevalence, life expectancy, and health care structure.[2]

Owing to the decrease in smoking rates during recent years, it was argued that national screening programs may no longer be effective clinically or cost effective.[18] An analysis of individual patient data on the incidence of AAA, AAA mortality, and surgery for AAA in a cohort of Swedish men aged 65 years showed that AAA mortality had decreased considerably between the early 2000s and 2015, and AAA screening was no longer associated with a significant decrease in AAA-related mortality.[19] These data are, however, contradicted by national screening studies in Sweden, which suggest that screening among 65-year-old men has resulted in a significant reduction in AAA-related mortality.[20] Owing to the lower prevalence of AAAs in females, it was supported that an AAA screening program for women may not be cost effective.[21]

In contrast, a recent cost-utility analysis from Ontario, Canada, compared a one-time ultrasound-based AAA screening vs no screening for people aged 65 years.[22] It was demonstrated that screening decreased the lifetime risk of AAA-related deaths from 0.53% to 0.08% (84.9%)

Table I. Responses of the Delphi consensus participants to the topic: "Should the size threshold for elective abdominal aortic aneurysm (AAA) repair be lowered to 5.0 cm for male and to 4.8 cm for female patients in the endovascular era?"

	First round	Second round	Third round
Yes	5 (11.4)	4 (9.1)	3 (6.8)
Probably yes	7 (15.9)	5 (11.4)	6 (13.6)
Possibly yes	5 (11.4)	6 (13.6)	6 (13.6)
Uncertain/unknown/ unproven/no opinion	2 (4.5)	1 (2.3)	1 (2.3)
Possibly no	4 (9.1)	5 (11.4)	4 (9.1)
Probably no	6 (13.6)	6 (13.6)	8 (18.2)
No	15 (34.1)	17 (38.6)	16 (36.4)
Total	44 (100)	44 (100)	44 (100)

Values are number (%).

in males and from 0.21% to 0.04% (81.0%) in females. At a willingness to pay threshold of $50,000/year, screening was cost effective in 84% of males and 90% of females.[22] An earlier cost data analysis using the Veterans Affairs data in the United States similarly concluded that AAA screening programs are still feasible and cost effective.[23] A Markov model study performed in Sweden suggested that screening for AAAs among men remains cost effective, even if the prevalence of the disease is as low as 0.5%.[24] Although the prevalence of AAAs has been lower in recent reports from screening programs compared with the original RCTs evaluating the possible benefit of AAA screening, the current prevalence reported from Sweden and the UK is above this threshold level.[25]

It has been supported that vascular surgeons fall short in patient screening for AAAs.[26,27] There are three patient populations that are excluded from the guidelines, but are worthy of further examination to reconsider coverage, namely, nonsmokers with other equivalent risk factors, patients >75 years, and women.[26,27] At present, only women aged 65 to 75 years with a family history of AAA may undergo screening. In the absence of a positive family history, even a woman with multiple risk factors and a high risk of AAA would not qualify for screening.[26,27] Despite the current guidelines and recommendations, <15% of eligible patients undergo AAA screening.[28] It was thus supported that AAA screening should be expanded.[29]

A study retrospectively attempted to define the number of patients who would have been identified as having criteria for screening for AAA among 55,197 patients undergoing AAA repair in the Vascular Quality Initiative (44,602 undergoing EVAR and 10,595 undergoing open repair).[30] It was demonstrated that by use of the US Preventive Services Task Force guidelines fewer than one-third of the patients would have been identified (32% EVAR and 33% open repair).[30] By application of the SVS guidelines, the number of patients meeting the criteria for screening increased by 6% for EVAR and by 12% for the open repair cohorts. Finally, adoption of the expanded SVS criteria (ie, men or women ≥65 years of age with first-degree relatives with AAA and men or women >75 years with a history of tobacco use) increased the rate of identified patients by 34% among the EVAR cohort and by 33% among the open repair group.[30] Still, 28% of patients undergoing AAA repair did not meet any criteria for screening, in particular patients <65 years with a history of heavy tobacco use and those ≥65 years with no smoking history.[30]

Overall, 75% of the Delphi consensus participants (33 of 44) voted that AAA screening programs are (probably) still clinically effective and cost-effective today (Table II), although 4 participants supported that such screening programs are clinically effective, but may not be cost effective.

Table II. Responses of the Delphi consensus participants to the topic: "Are abdominal aortic aneurysm (AAA) screening programs still clinically effective and cost-effective today?"

	First round	Second round	Third round
Yes	12 (27.3)	13 (29.5)	14 (31.8)
Probably yes	16 (36.4)	19 (43.3)	19 (43.3)
Possibly yes	3 (6.8)	3 (6.8)	2 (4.5)
Uncertain/unknown/ unproven/no opinion	5 (11.4)	3 (6.8)	3 (6.8)
Possibly no	3 (6.8)	2 (4.5)	2 (4.5)
Probably no	3 (6.8)	1 (2.3)	1 (2.3)
No	2 (4.5)	3 (6.8)	3 (6.8)
Total	44 (100)	44 (100)	44 (100)

Values are number (%).

Is prophylaxis for deep venous thrombosis needed for patients undergoing EVAR?. Whether or not AAA patients undergoing EVAR should receive prophylaxis for deep venous thrombosis is another controversial issue. Earlier studies have produced conflicting results, with some centers reporting a low incidence[31] and others reporting a high incidence of deep venous thrombosis after EVAR.[32]

A single-center study reporting the rate of venous thromboembolism (VTE) in patients (n = 1021) undergoing EVAR or open AAA repair over 15 years (February 2001 to December 2016; 59% EVAR; 41% open AAA repair) reported an incidence of 2.4% after open repair compared with 1.0% after EVAR.[33] These results were verified in a study reporting the incidence of VTE after elective vascular procedures (n = 45,548) in the 2007-2009 National Surgical Quality Improvement Program database.[34] Of these, there were 6195 open AAA surgery and 7361 EVAR procedures. VTE was diagnosed in 1.7% of patients undergoing open AAA surgery and 0.7% of those undergoing EVAR.[34]

A systematic review and meta-analysis (n = 42 studies; 20,753 patients) compared VTE complications in patients receiving some form of VTE prophylaxis (n = 13,241 [64%]) vs those without VTE prophylaxis (n = 7512 [36%]).[35] Of the 13,241 patients receiving some form of VTE prophylaxis, 197 (1.5%) developed VTE, whereas of the 7512 patients not receiving any prophylaxis, 72 (0.96%) developed VTE. It was claimed that the risk of VTE after open aortic reconstruction is 13% to 18% and it is not decreased by VTE prophylaxis. For EVAR patients, the risk of VTE is around 6% and this incidence may be decreased by VTE prophylaxis.[35] The authors concluded that, based on the findings of their systematic review, it seems reasonable to suggest that all vascular surgery patients should receive pharmacological VTE prophylaxis in

the perioperative period to prevent VTE events in a few patients. However, if a surgeon deems a patient to be at high risk for bleeding, it may be reasonable to avoid pharmacological VTE prophylaxis in the immediate postoperative period, because this may be associated with increased risk of bleeding.[35]

The 2024 ESVS AAA guidelines added a new recommendation regarding thromboprophylaxis in patients undergoing AAA repair.[2] It was stated that, although routine VTE prophylaxis is recommended after major abdominal and orthopedic surgeries, there is a paucity of literature that addresses the effectiveness of VTE prophylaxis specifically in the AAA repair setting.[2] It was recommended that all patients undergoing elective AAA repair and deemed at risk of postoperative VTE should be considered for thromboprophylaxis (Class: IIa; Level of Evidence: C).[2] This recommendation expanded the 2018 SVS AAA guidelines, which provided a strong recommendation for intermittent pneumatic compression and early ambulation for all patients undergoing open AAA repair or EVAR (Level: I [strong]; Quality of Evidence: A [high]).[1] A weaker recommendation for thromboprophylaxis with unfractionated or low-molecular-weight heparin was suggested for patients undergoing AAA repair at moderate to high risk for VTE and low risk of bleeding (Level of recommendation: 2 [weak]; Quality of Evidence: C [low]).[1]

The votes of the Delphi consensus participants were mixed on this issue reflecting the uncertainty in the published literature. Approximately 60% of the group provided a stronger or weaker support for thromboprophylaxis for patients undergoing EVAR, whereas the remaining 40% did not think that thromboprophylaxis is necessary (Table III). For patients undergoing standard EVAR procedures, routinely receiving heparin during the procedure, who are mobilized the same day of the procedure and are discharged home quickly postoperatively (eg, within 1 day), it was thought that thromboprophylaxis may not be necessary.

Should there be a minimum case volume for a center to offer open AAA repair/EVAR?. The 2018 SVS guidelines suggested that elective EVAR be performed at centers with a volume of ≥10 EVAR cases each year and a documented perioperative mortality and conversion rate to open surgery of ≤2%.[1] According to the 2024 ESVS guidelines, centers performing AAA repair should not have a yearly total caseload of <30 procedures, and <than 15 each by open and endovascular methods (Class: III; Level of Evidence: B).[2]

A study using data from the Medicare program of the National Inpatient Sample identified all elective AAA repairs between 2001 and 2008 (n = 122,495 patients; EVAR, 77,044; open repair, 45,451).[36] For EVAR, perioperative mortality did not differ by surgeon volume (quintile 1, 0-9 EVAR procedures [1.9%]; quintile 5, 28-151 EVAR procedures [1.6%]; $P = .29$), but decreased with greater hospital volume (quintile 1, 0-9 EVAR procedures [1.9%]; quintile 5, 49-198 EVAR procedures [1.4%]; $P < .01$).[36] For open repair, perioperative mortality decreased with both higher surgeon volume (quintile 1, 0-3 open repairs [6.4%]; quintile 5, 14-62 open repairs [3.8%]; $P < .01$) and hospital volume (quintile, 1 0-5 open repairs [6.3%]; quintile 5, 14-62 open repairs [3.8%]; $P < .01$).[36] Surgeon volume was not associated with perioperative mortality after EVAR after adjustment for patient comorbidities and hospital volume. In contrast, higher surgeon volume was associated with lower perioperative mortality after open repair ($P < .05$).[36]

Table III. Responses of the Delphi consensus participants to the topic: "Is prophylaxis for deep venous thrombosis needed for patients undergoing endovascular abdominal aortic aneurysm repair (EVAR)?"

	First round	Second round	Third round
Yes	7 (15.9)	9 (20.4)	10 (22.6)
Probably yes	9 (20.4)	12 (27.4)	13 (29.7)
Possibly yes	6 (13.6)	5 (11.4)	4 (9.1)
Uncertain/unknown/ unproven/no opinion	2 (4.5)	-	-
Possibly no	5 (11.4)	6 (13.6)	6 (13.6)
Probably no	8 (18.3)	6 (13.6)	5 (11.4)
No	7 (15.9)	6 (13.6)	6 (13.6)
Total	44 (100)	44 (100)	44 (100)

Values are number (%).

International registry-based evaluations of volume outcome in aortic surgery have been performed by the International Consortium of Vascular Registries.[37] In an analysis of 178,302 aortic repairs performed in 11 countries, a distinct volume-outcome relationship was present for open aortic repair with perioperative mortality as the measured outcome. The threshold at which the volume-outcome relationship stabilized was calculated to be at an annual center volume of 13 to 16 open aortic repairs.[37] The volume-outcome relationship in aortic surgery is likely to be related to the concept of failure to rescue, which assesses the possibility to rescue a complication and avoid fatality.[38] Failure to rescue is more common in low-volume centers both after open repair and EVAR.[38]

A similar study from the UK investigating the volume-outcome relationship in elective AAA surgery included 31,829 procedures (8867 open AAA repairs and 22,962 EVAR).[39] For open surgery, lower surgeon annual volume was associated with a higher 30-day mortality and length of hospital stay greater than the median. For EVAR, lower surgeon annual volume was associated with not having an overnight stay in critical care. None of the other volume-outcome relationships investigated were significant.[39]

A different conclusion was reached in a nationwide study from Germany including 84,631 intact AAAs.[40] The crude overall in-hospital mortality for intact AAA repair was 3.3% (1.7% for EVAR and 5.3% for open AAA surgery). Hospitals were listed in four quartiles depending on the number of AAA procedures/year performed. Within quartile 1, hospitals performed a median number of three AAA operations per year. Within quartile 4, hospitals operated on a median of 57 AAA patients per year. Volume was associated inversely with mortality after both open AAA repair and EVAR. The relative risk for in-hospital mortality was higher in quartile 1 hospitals for both EVAR (3.0% for quartile 1 vs 1.6% for quartile 4) and open AAA repair (7.6% for quartile 1 vs 4.5% for quartile 4).[40] Several recent studies verified the association between high case volume and lower mortality rates in both open AAA repair and EVAR.[41-43]

Most Delphi consensus participants (42 of 44 [95.4%]) voted that there should be/there should probably be a minimum case volume for a center to offer open AAA repair/EVAR (Table IV). Of these, 5 of the 42 participants (11.9%) thought that a minimum case volume was necessary for open AAA surgery, but not for EVAR.

Should surveillance after EVAR be lifelong?. According to the 2018 SVS Guidelines, lifelong surveillance after EVAR is required for the detection of endoleaks or device migration.[1] However, in the last couple of years, the need for lifelong surveillance after EVAR has been questioned. A multicenter, retrospective, observational study included all consecutive patients (n = 1596) at 16 academic and teaching hospitals in the Netherlands with an AAA who underwent elective EVAR between January 2007 and January 2012.[44] Of these, 552 patients had continued yearly imaging surveillance, and 1044 discontinued. Freedom from AAA-related death was 96.9% and 92.0% at 5 and 10 years for patients with continued follow-up, and it was 99.7% and 98.0% at 5 and 10 years, respectively, for patients who discontinued follow-up (log rank $P < .001$).[44] Overall survival was higher in patients with discontinued imaging follow-up (log rank $P < .001$). Overall survival was 80.3% and 49.6% at 5 and 10 years for patients with discontinued imaging follow-up, while it was 58.6 and 35.5% at 5 and 10 years for patients with continued follow-up. Twenty-nine patients (1.8%) presented with AAA rupture (10 of 552 vs 19 of 1044 patients, or 1.8% vs 1.8%, respectively).[44] The causes of aneurysm rupture were type I endoleak in 15 patients (3 of 15 previously detected on imaging surveillance), type II endoleak in 3 patients (2 of 3 previously detected), 1 patient with a type III endoleak (not previously detected), 2 patients with endograft kinking (not previously detected), and in 8 patients no cause or previously detected abnormalities were recorded.[44] It was concluded that discontinued follow-up is not associated with poor outcomes.[44]

Table IV. Responses of the Delphi consensus participants to the topic: "Should there be a minimum case volume for a center to offer open abdominal aortic aneurysm (AAA) repair or endovascular abdominal aortic aneurysm repair (EVAR)?"

	First round	Second round	Third round
Yes	27 (61.2)	33 (77.1)	35 (79.4)
Probably yes	11 (25.1)	8 (18.3)	7 (16.0)
Possibly yes	5 (11.4)	1 (2.3)	1 (2.3)
Uncertain/unknown/ unproven/no opinion	-	1 (2.3)	1 (2.3)
Possibly no	-	1 (2.3)	-
Probably no	1 (2.3)	-	-
No	-	-	-
Total	44 (100)	44 (100)	44 (100)

Values are number (%).

The 2024 ESVS AAA guidelines[2] suggested a follow-up algorithm after EVAR, risk stratifying patients into three groups. The first is the low-risk group (no endoleak, anatomy within the instructions for use, and no high-risk features, such as a proximal neck diameter of <30 mm, angulation of <60°, and iliac diameter of <20 mm). These patients could be considered for limited follow-up, with delayed imaging until 5 years after repair. The second is the high-risk group (presence of type II endoleak, anatomy outside the instructions for use, insufficient overlap or seal <10 mm, proximal neck >30 mm, ectatic iliac fixation zones [>20 mm] or extreme angulation [>60°]). These patients could be considered for yearly examinations with either computed tomography angiography or duplex ultrasound examination. Patients with sac shrinkage of ≥10 mm can be regarded as low risk of failure, cross over to the low-risk group, and repeat imaging only until 5 years after the operation. The third group is the EVAR failure group (direct type I or type III endoleak, obvious degradation of seal zones, or aneurysm sac growth of >10 mm) that should be considered for secondary intervention.

Although most Delphi consensus participants (36 of 44 [81.9%]) voted that surveillance after EVAR should be/should probably be lifelong, 3 of 36 (8.3%) argued that surveillance may be of little meaning if the patient gets too old and/or is no longer fit for an additional procedure (if he/she requires one), or there is complete regression of the AAA sac (Table V).

Should women smokers be screened for AAAs at 65 years of age, similar to men?. The pooled prevalence of AAAs in women over 60 years has been estimated to be approximately 0.7%, ie, up to 4 times less than in men.[45-47] Despite this much lower prevalence, women with AAAs are four times more likely to

Table V. Responses of the Delphi consensus participants to the topic: "Should surveillance after endovascular abdominal aortic aneurysm repair (EVAR) be lifelong?"

	First round	Second round	Third round
Yes	18 (40.1)	26 (59.2)	26 (59.2)
Probably yes	14 (32.6)	10 (22.7)	10 (22.7)
Possibly yes	1 (2.3)	-	-
Uncertain/unknown/ unproven/no opinion	3 (6.8)	2 (4.5)	2 (4.5)
Possibly no	2 (4.5)	-	-
Probably no	5 (11.4)	3 (6.8)	3 (6.8)
No	1 (2.3)	3 (6.8)	3 (6.8)
Total	44 (100)	44 (100)	44 (100)

Values are number (%).

Table VI. Responses of the Delphi consensus participants to the topic: "Should women smokers be screened for abdominal aortic aneurysms (*AAAs*) at 65 years of age similar to men?"

	First round	Second round	Third round
Yes	14 (31.8)	13 (29.5)	12 (27.2)
Probably yes	13 (29.5)	14 (31.8)	16 (36.6)
Possibly yes	6 (13.6)	8 (18.4)	7 (15.9)
Uncertain/unknown/ unproven/no opinion	5 (11.4)	3 (6.8)	3 (6.8)
Possibly no	1 (2.3)	2 (4.5)	2 (4.5)
Probably no	4 (9.1)	2 (4.5)	2 (4.5)
No	1 (2.3)	2 (4.5)	2 (4.5)
Total	44 (100)	44 (100)	44 (100)

Values are number (%).

experience an AAA rupture compared with men of the same age, and have >40% higher in-hospital mortality rates after elective EVAR or open AAA repair procedures compared with men.[45-47] It was supported that these higher mortality rates may have an impact on the benefit offered by any screening program offered to women.[46]

In contrast, a large study (n = 65,125 admissions for ruptured AAAs and 461,191 repairs for intact AAAs) demonstrated that nearly 60% of patients who had undergone repair for ruptured AAAs did not meet the criteria for screening.[48] Of the patients who did not qualify, 27,653 (63%) were aged >75 years, 10,603 (24%) were aged <65 years and 16,103 (36%) were women.[48] Female patients accounted for disproportionally high percentages of in-hospital mortality, comprising 35% of deaths for all patients with AAA rupture and 27% of deaths after repair. Women had a postoperative mortality rate of 41% (31% with EVAR vs 45% for open ruptured AAA repair; $P < .001$).[48] The findings of this study hold implications for screening. As the authors supported, Medicare only reimburses screening for women with a family history of AAA, which according to presented data, would only be 2% of those women whose AAA will rupture.[48] Furthermore, it was argued that the United States Preventive Services Task Force recommending against screening women,[49] excludes approximately 30% of the patients presenting with a ruptured AAA.

Most Delphi consensus participants (35 of 44 [79.7%]) provided either stronger or weaker support for screening women smokers at 65 years of age, similar to men (Table VI).

Limitations. A Delphi consensus has inherent and specific limitations. Although the participants were highly experienced and voted based on their personal expertise and the available literature, their responses were subjective and not based on Level I evidence. Furthermore, the individual experience of the participants in open aortic reconstruction/open retroperitoneal work and/or endovascular procedures has an important role in decision-making and may have influenced their vote. The learning curve on some procedures (eg, open aortic reconstruction or complex AAA surgery) varies for different surgeons and it may not be easy to establish how many cases one needs to be labeled as proficient in a given surgical procedure. All panelists were either from the United States or from the European Union. Selection of different experts to participate in a similar Delphi consensus from other countries or continents could lead to different results and conclusions. In addition, female participants were under-represented in the present Delphi consensus document either because they declined or because they failed to respond to the invitation to participate. A greater participation of female participants could have resulted in different responses. Finally, the views of experts from different countries may be influenced by local market needs, or may apply to the population of this particular country and may not be generalizable.

CONCLUSIONS

This international, expert-based Delphi consensus document provides some guidance for clinicians on specific controversial or unresolved topics in the management of patients with infrarenal AAAs. Although a consensus was achieved in certain topics, this was not possible in others, highlighting the need for further research and better quality evidence.

AUTHOR CONTRIBUTIONS

Conception and design: KP

Analysis and interpretation: KP, MS, SH, AB, HV, JL, EV, JB, TK, SL, DC, GF, TB, MD, KM, KS, EG, JF, AK, SL, AV, PM,

MK, AM, CZ, RP, ND, AK, MB, DS, MV, MF, MB, GM, VR, ME, MG, SS, GT, ME, BP, PG, MM, RD
Data collection: KP
Writing the article: KP
Critical revision of the article: KP, MS, SH, AB, HV, JL, EV, JB, TK, SL, DC, GF, TB, MD, KM, KS, EG, JF, AK, SL, AV, PM, MK, AM, CZ, RP, ND, AK, MB, DS, MV, MF, MB, GM, VR, ME, MG, SS, GT, ME, BP, PG, MM, RD
Final approval of the article: KP, MS, SH, AB, HV, JL, EV, JB, TK, SL, DC, GF, TB, MD, KM, KS, EG, JF, AK, SL, AV, PM, MK, AM, CZ, RP, ND, AK, MB, DS, MV, MF, MB, GM, VR, ME, MG, SS, GT, ME, BP, PG, MM, RD
Statistical analysis: Not applicable
Obtained funding: Not applicable
Overall responsibility: KP

DISCLOSURES

A.K. has received speaker fees from Cook Inc., & W.L. Gore & Associates, and is a consultant for Bentley Innomed. M.A.F. has received clinical trial support and is a Consultant for Cook, W. L. Gore & Associates, Getinge, and ViTAA. He has received research support from Cook and has stock options in Centerline Biomedical. M.E. is a paid consultant for W. L. Gore & Associates and Silk Road Medical. M.G. is a consultant for Cook Medical, W. L. Gore & Associates and Medtronic and a proctor for Cook Medical.

REFERENCES

1. Chaikof EL, Dalman RL, Eskandari MK, et al. The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm. *J Vasc Surg*. 2018;67:2–77.
2. Wanhainen A, Van Herzeele I, Bastos Goncalves F, et al. Editor's choice–European Society for Vascular Surgery (ESVS) 2024 clinical practice guidelines on the management of abdominal aorto-iliac artery aneurysms. *Eur J Vasc Endovasc Surg*. 2024;67:192–331.
3. Wanhainen A, Verzini F, Van Herzeele I, et al. Editor's Choice - European society for vascular surgery (ESVS) 2019 clinical practice guidelines on the management of abdominal Aorto-iliac Artery aneurysms. *Eur J Vasc Endovasc Surg*. 2019;57:8–93.
4. Guidance on Conducting and reporting Delphi studies (CREDES) Checklist. Accessed March 13, 2024. Available at: https://cdn-links.lww.com/permalink/ta/c/ta_00_00_2022_04_14_costantini_jt-d-22-00126_sdc2.pdf.
5. MacLeod CS, Nagy J, Radley A, et al, REPAIRS Collaborative. REPAIRS Delphi: a UK and Ireland consensus statement on the management of infected arterial pseudoaneurysms secondary to groin injecting drug use. *Eur J Vasc Endovasc Surg*. 2024. Online ahead of print.
6. Soenens G, Gorden L, Doyen B, et al, ENDORATE-PVI consortium. Development and testing of Step, Error, and event frameworks to evaluate technical performance in peripheral endovascular interventions. *Eur J Vasc Endovasc Surg*. 2024;68:227–235.
7. Sirignano P, Piffaretti G, Ceruti S, et al, SAFE EVAR Collaborators. Insight from an Italian Delphi consensus on EVAR feasibility outside the instruction for use: the SAFE EVAR study. *J Cardiovasc Surg*. 2024;65:273–279.
8. Black SA, Gohel M, de Graaf R, et al, International Venous Delphi Consensus Study Group. Editor's choice - management of lower extremity venous outflow obstruction: results of an international Delphi consensus. *Eur J Vasc Endovasc Surg*. 2024;67:341–350.
9. Coelho A, Peixoto J, Canedo A, de Borst GJ, Mansilha A. A Delphi consensus study on patients undergoing Carotid Endarterectomy: patient reported outcome measures. *Eur J Vasc Endovasc Surg*. 2023;65:787–801.
10. Scali ST, Suckow BD, Goodney PP, et al. A significant proportion of current endovascular aortic aneurysm repair practice fails to meet Society for Vascular Surgery clinical practice guideline recommended abdominal aortic aneurysm diameter treatment thresholds in the Vascular Quality Initiative. *J Vasc Surg*. 2022;75:1234–1241.
11. Li B, Rizkallah P, Eisenberg N, Forbes TL, Roche-Nagle G. Thresholds for abdominal aortic aneurysm repair in Canada and United States. *J Vasc Surg*. 2022;75:894–905.
12. Fan EY, Buckner MA, LiCausi J, et al. Characterizing the frequency and indications for repair of abdominal aortic aneurysms with diameters smaller than recommended by societal guidelines. *J Vasc Surg*. 2023;77:1637–1648.
13. Bellamkonda KS, Zogg C, Nassiri N, et al. Characteristics and 1-year outcomes of patients with rupture of small abdominal aortic aneurysms. *J Vasc Surg*. 2023;77:1649–1657.
14. Bellamkonda KS, Nassiri N, Sadeghi MM, Zhang Y, Guzman RJ, Ochoa Chaar CI. Characteristics and outcomes of small abdominal aortic aneurysm rupture in the American College of Surgeons national surgical quality improvement program database. *J Vasc Surg*. 2021;74:729–737.
15. Columbo JA, Scali ST, Jacobs BN, et al. Size thresholds for repair of abdominal aortic aneurysms warrant reconsideration. *J Vasc Surg*. 2024;79:1069–1078.e8.
16. Kontopodis N, Metaxa E, Gionis M, Papaharilaou Y, Ioannou CV. Discrepancies in determination of abdominal aortic aneurysms maximum diameter and growth rate, using axial and orthogonal computed tomography measurements. *Eur J Radiol*. 2013;82:1398–1403.
17. WARRIORS Randomized Trial. Will aim to examine early EVAR in women. Endovascular Today, 2022 September 9. Accessed March 13, 2024. Available at: https://evtoday.com/news/warriors-randomized-trial-will-aim-to-examine-early-evar-in-women.
18. Johansson M, Jorgensen KJ, Brodersen J. Harms of screening for abdominal aortic aneurysm: is there more to life than a 0.46% disease-specific mortality reduction? *Lancet*. 2016;387:308–310.
19. Johansson M, Zahl PH, Siersma V, Jorgensen KJ, Marklund B, Brodersen J. Benefits and harms of screening men for abdominal aortic aneurysm in Sweden: a registry-based cohort study. *Lancet*. 2018;391:2441–2447.
20. Wanhainen A, Hultgren R, Linne A, et al, Swedish Aneurysm Screening Study Group (SASS). Outcome of the Swedish nationwide abdominal aortic aneurysm screening program. *Circulation*. 2016;134:1141–1148.
21. Sweeting MJ, Masconi KL, Jones E, et al. Analysis of clinical benefit, harms, and cost-effectiveness of screening women for abdominal aortic aneurysm. *Lancet*. 2018;392:487–495.
22. Vervoort D, Hirode G, Lindsay TF, Tam DY, Kapila V, de Mestral C. One-time screening for abdominal aortic aneurysm in Ontario, Canada: a model-based cost-utility analysis. *CMAJ*. 2024;196:E112–E120.
23. Lee ES, Chun KC, Gupta A, et al. Costs of abdominal aortic aneurysm care at a regional Veterans Affairs medical center with implementation of an abdominal aortic aneurysm screening program. *J Vasc Surg*. 2022;75:1253–1259.
24. Svensjo S, Mani K, Bjorck M, Lundkvist J, Wanhainen A. Screening for abdominal aortic aneurysm in 65-year-old men remains cost-effective with contemporary epidemiology and management. *Eur J Vasc Endovasc Surg*. 2014;47:357–365.
25. Svensjo S, Bjorck M, Gurtelschmid M, Djavani Gidlund K, Hellberg A, Wanhainen A. Low prevalence of abdominal aortic aneurysm among 65-year-old Swedish men indicates a change in the epidemiology of the disease. *Circulation*. 2011;124:1118–1123.
26. O'Donnell TFX, Schermerhorn ML. Abdominal aortic aneurysm screening guidelines: United States preventative services task force and Society for Vascular Surgery. *J Vasc Surg*. 2020;71:1457–1458.
27. Schermerhorn M. Updated US preventive services task force recommendations for abdominal aortic aneurysm-are we really up to date? *JAMA Surg*. 2020;155:101–103.
28. Rokosh RS, Mastracci TM, Chaikof EL. Society for Vascular Surgery implementation of clinical practice guidelines for patients with an abdominal aortic aneurysm: screening for an abdominal aortic aneurysm. *J Vasc Surg*. 2021;73:1126–1127.
29. O'Donnell TFX, Landon BE, Schermerhorn ML. The case of expanding abdominal aortic aneurysm screening. *J Vasc Surg*. 2020;71:1809–1812.
30. Carnevale ML, Koleilat I, Lipsitz EC, Friedmann P, Indes JE. Extended screening guidelines for the diagnosis of abdominal aortic aneurysm. *J Vasc Surg*. 2020;72:1917–1926.

31. Eagleton MJ, Grigoryants V, Peterson DA, et al. Endovascular treatment of abdominal aortic aneurysm is associated with a low incidence of deep venous thrombosis. *J Vasc Surg*. 2002;36:912–916.
32. de Maistre E, Terriat B, Lesne -Padieu AS, Abello N, Bouchot O, Steinmetz EF. High incidence of venous thrombosis after surgery for abdominal aortic aneurysm. *J Vasc Surg*. 2009;49:596–601.
33. Khan NK, Oksala NK, Suominen V, Vakhitov D, Laurikka JO, Khan JA. Risk of symptomatic venous thromboembolism after abdominal aortic aneurysm repair in long-term follow-up of 1021 consecutive patients. *J Vasc Surg Venous Lymphat Disord*. 2021;9:54–61.
34. Ramanan B, Gupta PK, Sundaram A, et al. Development of a risk index for prediction of mortality after open aortic aneurysm repair. *J Vasc Surg*. 2013;58:871–878.
35. Toth S, Flohr TR, Schubart J, Krehans A, Castello MC, Aziz F. A meta-analysis and systematic review of venous thromboembolism prophylaxis in patients undergoing vascular surgery procedures. *J Vasc Surg Venous Lympat Disord*. 2020;8:869–881.
36. Zettervall SL, Schermerhorn ML, Soden PA, et al. The effect of surgeon and hospital volume on mortality after open and endovascular repair of abdominal aortic aneurysms. *J Vasc Surg*. 2017;65:626–634.
37. Scali ST, Beck AW, Sedrakyan A, et al. Hospital volume association with abdominal aortic aneurysm repair mortality: analysis of the international Consortium of vascular registries. *Circulation*. 2019;140:1285–1287.
38. D'Oria M, Scali S, Mao J, et al. Endovascular repair of intact abdominal aortic aneurysms in the VASCUNET and international Consortium of vascular registries. *Ann Surg*. 2021;274:e452–e459.
39. Gray WK, Day J, Horrocks M. Editor's choice - volume-outcome relationships in elective abdominal aortic aneurysm surgery: analysis of the UK hospital episodes statistics database for the getting it right first time (GIRFT) programme. *Eur J Vasc Endovasc Surg*. 2020;60:509–517.
40. Trenner M, Kuehnl A, Salvermoser M, et al. Editor's Choice - high annual hospital volume is associated with decreased in hospital mortality and complication rates following treatment of abdominal aortic aneurysms: secondary data analysis of the nationwide German DRG Statistics from 2005 to 2013. *Eur J Vasc Endovasc Surg*. 2018;55:185–194.
41. Esce A, Medhekar A, Fleming F, et al. Increasing surgeon volume correlates with patient survival following open abdominal aortic aneurysm repair. *J Vasc Surg*. 2019;70:762–767.
42. Esce A, Medhekar A, Fleming F, et al. Superior 3-year value of open and endovascular repair of abdominal aortic aneurysm with high-volume providers. *Ann Vasc Surg*. 2018;46:17–29.
43. Scali ST, Arnaoutakis DJ, Neal D, et al. Association between surgeon case volume and years of practice experience with open abdominal aortic aneurysm repair outcomes. *J Vasc Surg*. 2021;73:1213–1226.
44. Geraedts ACM, Mulay S, Vahl AC, et al, ODYSSEYS study group. Editor's choice- post-operative surveillance and long term outcome after endovascular aortic aneurysm repair in patients with an initial post-operative computed tomography Angiogram without abnormalities: the multicentre retrospective ODYSSEUS study. *Eur J Vasc Endovasc Surg*. 2022;63:390–399.
45. Duncan A, Maslen C, Gibson C, et al. Ultrasound screening for abdominal aortic aneurysm in high-risk women. *Br J Surg*. 2021;108:1192–1198.
46. Sidloff DA, Saratzis A, Sweeting MJ, et al. Sex differences in mortality after abdominal aortic aneurysm repair in the UK. *Br J Surg*. 2017;104:1656–1664.
47. Sweeting MJ, Thompson SG, Brown LC, Powell JT, RESCAN collaborators. Meta-analysis of individual patient data to examine factors affecting growth and rupture of small abdominal aortic aneurysms. *Br J Surg*. 2012;99:655–665.
48. Dansey KD, Varkevisser RRB, Swerdlow NJ, et al. Epidemiology of endovascular and open repair for abdominal aortic aneurysms in the United States from 2004 to 2015 and implications for screening. *J Vasc Surg*. 2021;74:411–424.
49. US Preventive Services Task Force, Owens DK, Davidson KW, Krist AH, et al. Screening for abdominal aortic aneurysm: US preventive Services Task Force recommendation Statement. *JAMA*. 2019;322:2211–2218.

Submitted Apr 21, 2024; accepted Aug 3, 2024.

Additional material for this article may be found online at www.jvascsurg.org.

APPENDIX (online only).

List of references provided to the participants of the Delphi consensus document during round 2 for each topic.

1. Should the size threshold for elective abdominal aortic aneurysm (AAA) repair be lowered to 5.0 cm for male and to 4.8 cm for female patients in the endovascular era?
   a. Bellamkonda KS, Zogg C, Nassiri N, Sadeghi MM, Zhang Y, Guzman RJ, et al. Characteristics and 1-year outcomes of patients with rupture of small abdominal aortic aneurysms. J Vasc Surg 2023;77:1649-1657.
   b. Fan EY, Buckner MA, LiCausi J, Crawford A, Boitano LT, Malka KT, et al. Characterizing the frequency and indications for repair of abdominal aortic aneurysms with diameters smaller than recommended by societal guidelines. J Vasc Surg 2023;77:1637-1648.
   c. Bellamkonda KS, Nassiri N, Sadeghi MM, Zhang Y, Guzman RJ, Ochoa Chaar CI. Characteristics and outcomes of small abdominal aortic aneurysm rupture in the American College of Surgeons National Surgical Quality Improvement Program database. J Vasc Surg 2021;74:729-737.
   d. Deery SE, Schermerhorn ML. Should abdominal aortic aneurysms in women be repaired at a lower diameter threshold? Vasc Endovascular Surg 2018;52:543-547.
   e. Columbo JA, Scali ST, Jacobs BN, Scully RE, Suckow BD, Huber T, et al. Size thresholds for repair of abdominal aortic aneurysms warrant reconsideration. J Vasc Surg 2024 Jan 21;S0741-5214(24)00,077-6. https://doi.org/10.1016/j.jvs.2024.01.017.
   f. Talvitie M, Stenman M, Roy J, Leander K, Hultgren R. Sex differences in rupture risk and mortality in untreated patients with intact abdominal aortic aneurysms. J Am Heart Assoc 2021;10:e019592.
   g. Talvitie M, Jonsson M, Roy J, Hultgren R. Association of women-specific size threshold and mortality in elective abdominal aortic aneurysm repair. Br J Surg 2024;111:znad376.
   h. Martinelli O, Cuozzo S, Miceli F, Gattuso R, D'Andrea V, Sapienza P, et al. Elective endovascular aneurysm repair (EVAR) for the treatment of infrarenal abdominal aortic aneurysms of 5.0-5.5 cm: differences between men and women. J Clin Med 2023;12:4364.
   i. Laine MT, Vanttinen T, Kantonen I, Halsesmaki K, Weselius EM, Laukontaus S, et al. Rupture of abdominal aortic aneurysms in patients under screening age and elective repair threshold. Eur J Vasc Endovasc Surg 2016;51:511-516.
2. Are AAA screening programs still clinically effective and cost-effective today?
   a. Søgaard R, Laustsen J, Lindholt JS. Cost effectiveness of abdominal aortic aneurysm screening and rescreening in men in a modern context: evaluation of a hypothetical cohort using a decision analytical model. BMJ 2012;345:e4276
   b. Wanhainen A, Lundkvist J, Bergqvist D, Björck M. Cost-effectiveness of different screening strategies for abdominal aortic aneurysm. J Vasc Surg 2005;41:741-751.
   c. Vervoort D, Hirode G, Lindsay TF, Tam DY, Kapila V, de Mestral C. One-time screening for abdominal aortic aneurysm in Ontario, Canada: a model-based cost-utility analysis. CMAJ 2024;196:E112-E120.
   d. Teles J, Teles N, Sousa H. Screening of the abdominal aortic aneurysm: cost-effectiveness and health benefits. Port J Card Thorac Vasc Surg 2021;28:39-48.
   e. Lee ES, Chun KC, Gupta A, Anderson RC, Irwin ZT, Newton EA, et al. Costs of abdominal aortic aneurysm care at a regional Veterans Affairs medical center with the implementation of an abdominal aortic aneurysm screening program. J Vasc Surg 2022l75:1253-1259.
   f. de Boer AR, Vaartjes I, van Dis I, van Herwaarden JA, Nathoe HM, Ruigrok YM, et al;UCC-SMART study group. Screening for abdominal aortic aneurysm in patients with clinically manifest vascular disease. Eur J Prev Cardiol 2022;29:1170-1176.
   g. Duncan A, Maslen C, Gibson C, Hartshorne T, Farooqi A, Saratzis A, et al. Ultrasound screening for abdominal aortic aneurysm in high-risk women. Br J Surg 2021;108:1192-1198.
   h. Dansey KD, Varkevisser RRB, Swerdlow NJ, Li C, de Guerre LEVM, Liang P, et al. Epidemiology of endovascular and open repair for abdominal aortic aneurysms in the United States from 2004 to 2015 and implications for screening. J Vasc Surg 2021;74:414-424.
   i. Fite J, Gimenez E, Soto B, Artigas V, Escudero JR, Bellmunt-Montoya S, et al. Systematic review on abdominal aortic aneurysm screening cost-efficiency and methodological quality assessment. Int Angiol 2021;40:67-76.
   j. Hultgren R, Elfstrom KM, Ohman D, Linne A. Long-term follow-up of men invited to participate in a population-based abdominal aortic aneurysm screening program. Angiology 2020;71:641-649.
   k. Nair N, Kvizhinadze G, Jones FT, Rush R, Khashram M, Roake J, et al. Health gains, costs and cost-effectiveness of a population-based screening programme for abdominal aortic aneurysms. Br J Surg 2019;106:1043-1054.
   l. Sprynger M, Willems M, Van Damme H, Drieghe B, Wautrecht JC, Moonen M. Screening program of abdominal aortic aneurysm. Angiology 2019;70:407-413.
3. Is prophylaxis for deep venous thrombosis (DVT) needed for patients undergoing EVAR?
   a. Morgan CE, Herm-Barabasz R, Rodriguez HE, Hoel AW, Eskandari MK. Incidence of acute lower extremity venous thrombosis after percutaneous endovascular aneurysm repair. J Vasc Surg 2015;62:351-354.
   b. Toth S, Flohr TR, Schubart J, Knehans A, Castello MC, Aziz F. A meta-analysis and systematic review

of venous thromboembolism prophylaxis in patients undergoing vascular surgery procedures. J Vasc Surg Venous Lymphat Disord 2020;8:869-881.
   c. Ramanan B, Gupta PK, Sundaram A, Lynch TG, MacTaggart JN, Baxter BT, et al. In-hospital and postdischarge venous thromboembolism after vascular surgery. J Vasc Surg 2013;57:1589-1596.
4. Should there be a minimum case volume for a center to offer open AAA repair/EVAR?
   a. Scali ST, Arnaoutakis DJ, Neal D, Giles KA, Goodney PP, Suckow BD, et al. Association between surgeon case volume and years of practice experience with open abdominal aortic aneurysm repair outcomes. J Vasc Surg 2021;73:1213-1226.
   b. Esce A, Medhekar A, Fleming F, Glocker R, Ellis J, Raman K, et al. Increasing surgeon volume correlates with patient survival following open abdominal aortic aneurysm repair. J Vasc Surg 2019;70:762-767.
   c. Sharma G, Madenci AL, Wanis KN, Comment LA, Lotto CE, Shah SK, et al. Association and interplay of surgeon and hospital volume with mortality after open abdominal aortic aneurysm repair in the modern era. J Vasc Surg. 2021;73:1593-1602.
5. Should surveillance after EVAR be lifelong?
   a. Andraska EA, Phillips AR, Reitz KM, Assadi S, Dai Y, Tzeng E, et al. Longer follow-up intervals following endovascular aortic aneurysm repair are safe and appropriate after marked aneurysm sac regression. J Vasc Surg 2022;76:454-460.
   b. Smith T, Quencer KB. Best Practice Guidelines: Imaging Surveillance After Endovascular Aneurysm Repair. AJR Am J Roentgenol 2020;214:1165-1174.
   c. Rakemaa L, Aho PS, Tulamo R, Laine MT, Laukontaus SJ, Hakovirta H, et al. Ultrasound surveillance is feasible after endovascular aneurysm repair. Ann Vasc Surg 2024;100:223-232.
6. Should women smokers be screened for AAAs at 65 years of age similar to men?
   a. Sweeting MJ, Masconi KL, Jones E, Ulug P, Glover MJ, Michaels JA, et al. Analysis of clinical benefit, harms, and cost-effectiveness of screening women for abdominal aortic aneurysm. Lancet 2018;392:487-495
   b. Duncan A, Maslen C, Gibson C, Hartshorne T, Farooqi A, Saratzis A, et al. Ultrasound screening for abdominal aortic aneurysm in high-risk women. Br J Surg 2021;108:1192-1198.
   c. Johansson M, Jorgensen K. Should we screen women for abdominal aortic aneurysm? Lancet 2018;392:454-456.
   d. Laine MT, Vanttinen T, Kantonen I, Halsesmaki K, Weselius EM, Laukontaus S, et al. Rupture of abdominal aortic aneurysms in patients under screening age and elective repair threshold. Eur J Vasc Endovasc Surg 2016;51:511-516.